LESSONS LEARNED: INTERPRETING WATER OR MONITORING WELL ANALYTICAL RESULTS

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MONITORING OR DOMESTIC WATER WELL WATER-QUALITY EVALUATION

- **Factors important to consider:**
  - Review of historical and baseline databases:
    - Must recognize natural variation in evaluation of data.
    - Must develop methods to determine what constitutes change.

- **Materials used in monitoring and water well construction:**
  - Since evaluating to ppb or ppt levels, must know if materials being used contain contaminants of interest at those levels.
  - Are those contaminants the same as being evaluated in your investigation (ppb levels).
  - Uncertainty of water well construction, how was it completed.
  - Evaluation of materials used in monitoring or water well construction to the low ppb levels.

- **Types of materials (commonly used in both monitoring and water well completions):**
  - Cements.
  - Drilling Muds or Drilling Completion Additives.
  - Monitoring or Water Well Completion Materials and Down hole Equipment.

HISTORICAL WATER-QUALITY DATA

- **Baseline data available in some shale gas areas (collected by operators)**
- **Useful for historical comparison of water-quality data**

- **Important historical databases:**
  - USGS National Water Information System (NWIS)
  - USGS National Uranium Resource Evaluation (NURE)
  - EPA STORET
  - Other Databases

- **USGS National Water Information System (NWIS)**
  - Data from the 1920's to present
  - Hundreds of thousands of analyses from water wells, springs, and surface waters
  - Mostly major ion chemistry, with some metals
  - Little methane analyses
  - Some limited organic and radionuclide analyses
  - Available online: http://waterdata.usgs.gov/nwis

HISTORICAL WATER-QUALITY DATA

- **USGS National Uranium Resource Evaluation (NURE)**
  - Date collected from 1976-1980.
  - Includes hundreds of thousands of water well samples, plus surface water and spring samples.
  - Parameter list variable, but typically includes radionuclides, bromide, chloride, sodium, TDS, and numerous metals. Also included observations related to groundwater odors from water wells, such as H2S .
  - No methane data.
  - Available online: http://mrdata.usgs.gov/nure/water/

- **EPA STORET and Other Databases**
  - May include incident or regulatory monitoring data.
  - May not be representative of background.
  - May include a wide variety of compounds, dependent on the monitoring program or incident.
  - Available online: http://www.epa.gov/storet/

BASELINE AND NATURAL VARIATION DATA REVIEW

- Historical and baseline databases.
- Baseline or background not a single value.
- Must recognize natural and sample/analytical variability in evaluation.
- What constitutes a change in water quality?
- Must recognize False Positives and data outliers.

SAMPLE COLLECTION AND PARAMETER RELATIONSHIPS

- Turbidity or sediment content of a sample can significantly affect the water-quality analyses and lead to False Positives.

- Recommend collecting both filtered (dissolved) and unfiltered (total) samples, especially for inorganic compounds (metals and radionuclides).

- Turbidity measurements must be made frequently during the sampling period, and especially at the same time the metals and radionuclides are collected.

- Many of the metal (e.g. aluminum, iron, manganese) and radionuclides in many areas are related to sediment issues in samples. Dissolved (field filtered) analyses of those same samples typically show the metals and radionuclides to be non-detected or much reduced.

MONITORING AND WATER WELL DRILLING OR COMPLETION MATERIAL EVALUATION

- **Monitoring and water wells typically use similar drilling and construction materials.**
- **What trace ppb levels of chemical contaminants do these materials contain.**
  - Casing materials
  - Drilling muds, air, cements, and additives
  - Sand
  - Screen
  - Centralizers
  - Cement baskets
  - Development materials (swabs, air, pump, piping)
- **Materials used must be carefully selected/screened to insure no chemicals of interest in an investigation are introduced by the well completion or development materials especially at the ppb or ppt levels.**
- **Decontamination must be conducted on ALL materials used downhole.**
- **Analyses of the decontamination fluids is required for each material cleaned or decontaminated to identify possible contaminants associated with those materials.**

MONITORING AND WATER WELL DRILLING OR COMPLETION CONTAMINANTS

- **DRILLING MUDS OR DRILLING/COMPLETION ADDITIVES**
  - What trace ppb or ppt levels of chemical contaminants may they contain?
    - Lubricants
    - Bentonite-based drilling muds
    - Dispersants
    - Clay/shale stabilizers
    - Additives
    - Wetting agents
    - Bentonite sealants
    - Cements (discussed earlier)
  - Even if approved for use in monitoring or water well completions, these materials typically are not tested for many chemical parameters, or not tested to low ppb or ppt levels.
  - Evaluation of a common lubricant approved for use in monitoring and water well completions show only about half (or less) of compounds that may be associated with hydraulic fracturing were analyzed. Those analyzed were typically not to the low ppb levels.

MONITORING AND WATER WELL DRILLING OR COMPLETION CONTAMINANTS

- **DRILLING MUDS OR DRILLING/COMPLETION ADDITIVES**
  - A detailed review of all drilling materials used down hole must be conducted before constructing monitoring wells and in evaluating data from domestic water wells to the extent possible.
  - Detailed analyses of all materials used downhole must be made, especially for those chemicals of interest in an investigation, and to the same level of detection, to avoid False Positive detections in groundwater samples caused by the materials themselves.
  - Technical investigators and reviewers must be aware of the possible contaminants present in materials used in monitoring or water well construction, and that knowledge used when evaluating groundwater quality data.
  - Do not assume because the product or material was approved for use in environmental applications that it was tested for the chemicals of interest in your investigation, or to the low ppb levels.

MONITORING AND WATER WELL DRILLING OR COMPLETION CONTAMINANTS

- **CEMENTS:**
  - Common Portland cements can contain high levels of glycols (tens to hundreds of ppm levels) and phenolic compounds (ppm levels) used as grinding aids in cement manufacture.
  - Common glycols in cements (Ervanne and Hakanen, 2007):
    - Ethylene Glycol
    - Diethylene Glycol
  - Other compounds potentially in cement (Ervanne and Hakanen, 2007):
    - Hydroxyethyl diethylenetriamine
    - Diethanolamine [ethanol]
    - Triethanolamine [ethanol]
    - Triisopropanolamine [isopropanol]
    - Aminoethylenthanolamine
    - Degradation or transformation products from these compounds
  - Glycols, phenols, and other compounds may also be present in hydraulic fracturing fluids.

MONITORING AND WATER WELL DRILLING OR COMPLETION CONTAMINANTS

- **CEMENTS:**
  - Cements used in water well or monitoring well construction can result in False Positive detection for glycols, phenols, isopropanol, or other parameters in groundwater samples, especially at the low ppb levels.
  - Many of the substances found in cements are not part of standard analytical parameter suites (8260 or 8270), or methods have not been commercially developed to get to low ppb levels for these parameters.

MONITORING OR WATER WELL DRILLING OR COMPLETION CONTAMINANTS

CASING OR COMPLETION MATERIALS:

- Use of painted or coated materials not recommended, as the paints can contain trace levels of contaminants such as 2-butoxyethanol (and many other organic compounds). 2-BE is a common component of almost all paint products and rust inhibitors, and has been a chemical of interest in hydraulic fracturing fluids.

- Most steel casings contain cutting/milling oils, and if threaded, threads commonly are sprayed or coated with rust inhibitors by the manufacturer prior to shipping. As such, those types of materials, if used, must be extensively decontaminated.

- If drilling or developing wells with air, hydrocarbons filters must be used on the compressor, or an oil-less compressor used. Compressor oils are in the air stream and can contaminate the groundwater with petroleum hydrocarbons, 2-BE, and many other organic compounds; they can also damage the formation.

CONCLUSIONS

- Review of baseline or historical water quality from an area and comparison to study data is an important component of any investigation.
- Background is not a single value. Evaluation of data must recognize and address natural and sampling-induced variability. Sample variability can be caused by analytical or sampling differences.
- Turbidity and sediment content can affect water-quality results for metals and radionuclides; samples collected should include a field filtered sample.
- An evaluation of water or monitoring well construction, drilling, or development materials must be conducted to the low ppb levels to determine if they could contribute to contaminants of interest.
- ALL equipment and materials used downhole must be thoroughly decontaminated and a sample of the decontaminated water collected for analyses to the low ppb levels.

CONCLUSIONS

- ALL drilling muds, air, additives and other materials used downhole must be analyzed for the chemicals of interest in an investigation and to the same low ppb or ppt analytical levels.

- Common cements used in well completions contain additives. Those additives can contribute glycols, phenols, isopropanol, and other contaminants to groundwater samples.

QUESTIONS?

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